Reviews

The Origin and Evolution of Life on the Theory of Action and Interaction of Energy. By HENRY FAIRFIELD OSBORN. Charles Scribner's Sons. Pp. xxi+322. Large 8vo.

This striking book is an elaboration of a series of lectures given as the Hale Lectures of the National Academy of Sciences, Washington, April, 1916. It is essentially an exposition of the author's "tetrakinetic theory," perhaps the most ambitious and comprehensive causo-mechanical theory of evolution since that of Darwin. Unlike most theories of evolution, which posit life already begun and deal with its subsequent evolution, the present author begins with a consideration of the lifeless world and discusses the physicochemical factors that favored the origin of living matter.

The viewpoint is avowedly dynamic and energistic throughout, and is therefore completely in accord with modern tendencies in biology, which are becoming progressively less morphological and more purely physiological.

The author has called into consultation many leaders in the various branches of science, including physics, physicochemics, immunology, geophysics, geochemics, astronomy, physiography, bacteriology, cytology, genetics, etc. The expert opinion of this competent group has been focused upon the solution of the problems in hand. No important body of knowledge that might bear on the subject is omitted or evaded.

In brief the author's "tetrakinetic theory" of evolution is that all evolutionary changes are the result of the continuous interaction of four energy systems, two of which are intrinsic or within the organism, and two extrinsic or outside of the organism. These four energy systems are:

1. Inorganic environment: the physicochemical energies of space, of the sun, earth, air, and water.

2. Organism: the physicochemical energies of the developing individual in the tissues, cells, protoplasm, and cell-chromatin.

3. Heredity-germ: physicochemical energies of the heredity chromatin, including the reproductive cells and tissues.

4. Life environment: physicochemical energies of other organisms.

The first and fourth factors are what we have usually called the environment and the second and third are what we have called heredity. According to the conventional view each generation of individuals is the result of the co-operation of heredity and environment. There is therefore nothing essentially new about this classification of energy complexes. What is really new is the consideration of these factors in terms of energy.

The inorganic environment is described as so highly adapted for organisms that the non-existence of the latter would be well-nigh inconceivable. In this the author follows closely L. J. Henderson and T. C. Chamberlin. The organism is viewed as a system of parts each affecting the growth of the others through the instrumentality of "chemical messengers" or hormones. It is this interaction of energies that gives organization to the individual and limits its size as a whole and the relative size of its parts. Gradual changes in the activity of one gland may alter quantitatively or qualitatively the chemical messengers produced by it, and progressive changes in one or many structures may result.

The heredity-chromatin of Osborn is evidently much like that of Morgan and his collaborators, with all of its intricate organization and its mechanism for producing new assortments of characters. The treatment of this energy system is a trifle vague and mystical in that it is supposed to go on its evolutionary way in a highly conservative fashion, guided only to a very limited extent by other energy complexes. Its changes are orderly and from generalized to specialized. Once the chromatin becomes specialized it cannot reverse and return to a generalized condition. The slow, orderly, self-contained changes of the heredity-chromatin are supposed to account for the orthogenetic phenomena so common in paleontological materials.

The "life environment" is, in a sense, a restatement in energy terms of Darwin's idea of the struggle for supremacy and survival of the fittest, but the struggle is inter- rather than intra-specific. Every environmental complex is a battleground on which the various groups that have become specialized for that particular complex struggle for space to multiply. One group may perfect an offensive equipment, another a defensive armament. Either type may go to extremes of specialization, so that a radical change of environment may find them nonplastic and irreversible. This is the author's explanation of many unaccountable extinctions.

Part II of the book is an application of the principles discussed in Part I to the evolution of the various animal groups. It must suffice

here merely to give the titles of the chapters: chap. iv, "The Origins of Animal Life and Evolution of the Invertebrates"; chap. v, "Visible and Invisible Evolution of the Vertebrates"; chap. vi, "Evolution of Body Form in the Fishes and Amphibia"; chap. vii, "Form Evolution of the Reptiles and Birds"; chap. viii, "Evolution of the Mammals."

The author is consistent throughout in viewing the organism as an energy complex. A great carnivorous Tyrannosaurus, for example, is chosen as a culmination of the offensive type of energy complex, while the horned herbivorous dinosaurs, known as Ceratopsia, are viewed as a defensive energy complex. The evolution of these two highly specialized complexes is an example of the "counteracting evolution" of offensive and defensive adaptations.

The book is so full of meat that the reviewer finds himself at a loss to do it justice in a limited space. So many stimulating suggestions are made in every chapter, indeed on almost every page, that one must read it carefully to get its full import. While there are many points that invite controversy, it must be borne in mind that the evident intention of the author is merely to establish a new threshold for departure, not to make an exhaustive explanation of evolutionary phenomena. The way toward future research in many lines is pointed out and a constructive plan for future work is outlined. This in itself is a contribution of the highest importance, since it places a new milestone beside that long and ancient highway of "the evolution of the evolution idea."

H. H. N.

Organic Evolution, a Text-Book. By RICHARD SWANN LULL. New York: Macmillan, 1917.

This compact volume of seven hundred and twenty-six pages and nearly three hundred figures, by the distinguished professor of vertebrate paleontology of Yale University, is one of the most satisfactory texts on organic evolution known to the writer. Especially satisfactory is it from the side of paleontology, and paleontology is and must remain the clearing house of all evolutional theories and doctrines. It treats of the history of the evolutional doctrine; the accepted and disputed factors of organic evolution; and the evidences of evolution, drawn from living and fossil organisms, including the origin of vertebrate life and of its chief groups; the adaptation, especially of vertebrates, to terrestrial, cursorial, volant, aquatic, desert, and cave life; the evolution of some of the best known types of mammals, the horses, elephants, camels, and,